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LUMMUS

INTER-OFFICE CORRESPONDENCE

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SUBJECT N.I. Gas Co.
East Dubuque, Illinois
Loess Soil

Loess is a fine grained aeolian deposit formed probably at the close of the glacial period by the dust storms from the barren outwash plains.

Origin & Description: Wind blown deposits may be encountered in two main zones, the zones of former glaciation and the desert belts. Depending upon the velocity of the particles in the air, two types of aeolian deposits are created:

a.) Sand Dunes: (Grain sizes ranging from .10 to .15 mm, with a range C_R varying from 2 to 3)

b.) Loess: (Approximately 50% of its grain sizes range between .05 to .01mm. Its range C_R varies from 3 to 5, and its grain size distribution curve is of type S and SC).

Loess is a wind blown dust of a predominantly silty nature. The shape of its grains is unweathered, angular, yellowish, brownish or grayish in color.

Loess is seldom stratified. Stratification may occur if loess was blown during different glacial periods. Some of it was deposited on grass; later the roots of the burried grass died and integrated with the dust. One type of loess that may be found stratified is the "swamp loess".

Some loess deposit include remains of fossils such as land snails.

Location: Loess occurs all over the world varying in type, color, and thickness which may range from 2' to 200'. As one goes east across the U.S.A. the loess worsen with respect to suitability for foundation soils. It occurs mostly in the proximity of the Mississippi Valley region. This particular Mississippi loess is called "abode".

Extensive deposits of loess are also found in Central Asia, North Africa, South America etc. There is a long belt of loess streching from France to China.

Mineral Composition: Quartz: 60% to 70%. Feldspar: 10% to 20%. Calcite: 10% to 25%. Quartz never changes. Calcite occurs in the decay of roots and is responsible for the cohesion, and the peculiar characteristics of loess. Feldspar desintegrates to Kaolin in humid conditions.

There are three types of loess: a) Typical loess. b) Loess - Loam (Feldspar has been transformed into clay minerals). c) Swamp loess. The main characteristics of these types are listed on the table shown below:

T A B L E

ITEM	TYPICAL LOESS	LOESS - LOAM	SWAMP LOESS
Clay sizes (.002 mm)	Smaller than 3%	Larger than 3%	Between 3 to 10%
Plasticity index PI.	Smaller than 5.	Larger than 5.	Between 5 to 10.
Lime containt	Larger than 10%	Smaller than 10%	None
Permeability in cm. per sec.	10^{-3} to 10^{-4}	10^{-6} to 10^{-7}	Smaller than 10^{-7}
Porosity = Volume of voids / Total Volume	40 to 60%	Smaller than 40%	Smaller than 40%

Engineering and Structural properties: The most unusual characteristic of loess is that - contrary to all other soils - the coefficient of permeability in the vertical directions is larger than the one in the horizontal direction.

This unusual property is probably due to lack of stratification plus the important fact that the particles of the wind blown dust contains sandy portions which are pervious providing vertical roots holes.

Loess has a high dry strength (cohesion) due to clay and calcareous binders. The cementing materials bind the silt and fine sand sizes together into an apparently stable structure under a dry condition. Sides of open cuts will stand almost vertical. However, when wet, or saturated, the structure may become completely unstable; the binder losses its adhesive effect, and thus the structure collapses. Minor changes in moisture result in changes in strength. True loess deposits have never been saturated.

In a remolded state its permeability and cohesion decrease and its compressibility increases.

Contrary to most soils the problem of settlement and bearing capacity cannot be disassociated. Experience in loess indicates that when the stress in the soil reaches a critical value the bond between the individual particles is broken; thus the material collapses. Normally the load = $3q_u$ (where q_u = unconfined compression). Using a factor of safety of 2.0 we have: safe load = $1.5q_u$. The choice of the factor of safety also depends on some natural density criteria.

1- For densities smaller than 80 pounds per cubic foot, the loess is in loose state, and highly susceptible to settlements when saturated, with or without foundation loads.

2- Loess with densities ranging from 80 to 90 pounds per cubic foot is medium dense and moderately susceptible to settlements upon saturation when loaded.

3- Densities higher than 90 pounds per cubic foot offer good support for ordinary structures even upon saturation.

Water contents above 20% will generally permit full settlement under load. Since the plasticity index for loess is generally less than 10, it is not subjected to swelling when saturated.

If loess is used for water retention structures such as canals, banks, dams, etc., linings or cutoffs are indicated. The permeability in this case is important, and the relative quantity of water will be the basis for determining the necessity for treatment.

In typical loess it is possible to dig a tunnel without supports, and excavate highway or railroad cuts with vertical walls. In arid climates inclined slopes in loess cannot be protected against rapid erosion.

Loading tests on loess may be completely misleading. The natural moisture % and porosity are important criteria. Saturated loess has a high porosity.

Loess may completely lose its original homogenuity because of local leaching or weathering. Many faulty foundations on loess resulted by failure to recognize these partial alterations. However, most of the failures occured because the structure of the loess became unstable upon saturation. Loess which is located permanently above the water table is relatively stable except that it may be eroded.

It is advisable to soften dry loess with water prior to pile driving.

Finally, in ending this, I would like to mention that the word "loess" is based on the name of an Alsacian town.

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